

Black rust of cotton: a preliminary note.¹

GEO. F. ATKINSON.

Early in the past season I began a study of the fungous diseases of the cotton plant with the special object to determine the disease called "black rust." The first of August, 1890, one hundred circular letters were sent to different farmers of Alabama requesting specimens of "black rust," "red rust," "Frenching," "root rot," etc. As it seemed probable that there was some confusion in the application of these names to certain appearances of the cotton a special request was made of the senders to carefully label the plants with the name applied by them to the disease.

From twenty-five to thirty replies were received including specimens marked "black rust," "red rust," and "root rot."²

The disease has been very prevalent and destructive during the season and excellent opportunities were afforded me for studying it in the vicinity of Auburn, not only upon the station farm but on neighboring plantations.

July 22d, on one of my visits to the cotton field, I found the disease had made its appearance in full force in several spots, where fully one-half of the leaves of the plants had fallen off, the remainder being curled, dried, and blackened by a profuse development of dark hyphæ and spores of several fungi, so that by suddenly jarring a leaf the spores would float off in clouds like the smut spores of some of the Ustilagineæ. Some of the plants showed still the earlier stages of the disease, and in other parts of the field were numerous opportunities to study the earlier stages. For two months my time was occupied in noting the external characters, collecting material, examining the different fungi found and noting the relation of each species to the variety of external characters presented in the progress of the disease.

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²The "root rot" disease was reported from only one place. The effects of the disease upon the plant are strikingly similar to those produced by the Texas disease which is caused by *Ozonium* according to Pammel, but due to an entirely different organism, a nematode worm, *Heterodera radicumicola*.

The fungi commonly present and which play an important part in the disease are *Cercospora Gossypina* Cooke, a species of *Colletotrichium*,¹ a *Macrosporium*,² an *Alternaria*, and frequently a pycnidial stage of some sphæriaceous fungus,³ and a bacterial organism which produces a characteristic disease of the leaves.

The bacterial disease is often very widely spread even when no evidences of the other fungi are to be found, but is mentioned here because frequently it is an accompaniment of the "black rust" and contributes materially to the aggravation of the disease. It is first manifested by a watery appearance in definite areolate spots which are bounded by the veinlets of the leaf. The spots are sometimes very numerous and frequently conjoined; often the disease follows one or more of the main ribs of the leaf being bounded on each side by an irregularly zigzag line. As the disease ages the spots become blackish and finally brown, frequently then bordered by a blackish color where the disease has extended somewhat centrifugally. The disease hastens the falling off of the leaves.

During the entire season, from July to the close of October, of the thousands of leaves old and young that I have examined, *Cercospora Gossypina* has been an almost universal accompaniment, and has not been second in point of attack, except perhaps in rare cases. In many cases parallel or immediately succeeding attacks were made by the *Colletotrichium*. The *Macrosporium* as a rule follows closely the attack of the *Cercospora*,⁴ indeed sometimes seeming to be the first to attack. In such cases possibly it attacked the spots diseased by *Cercospora* before the hyphæ and conidia of the latter were developed. The *Alternaria* usually succeeds the *Macrosporium*, though often seeming to be parallel with it. By its numerous clusters of hyphæ and profusely developed concate-

¹*C. Gossypii* E. A. Southworth.

²This seems to be an undescribed species for which I have proposed the name *Macrosporium nigricantium*. The hyphæ are amphigenous, subfasciculate or scattered .050-.140 mm. long \times .006-.007 mm. in diameter, nodulose, septate, olive brown. Conidia .018-.022 mm. \times .036-.050 mm. strongly constricted about the middle, stoutly rostrate at one side of the apex, smooth, transversely longitudinally and obliquely septate, olive brown. The nodulose hyphæ resemble those of such species as *M. parasiticum* Thuem.

³This is probably *Phyllosticta Gossypina* E. & M. Some recent cultures in agar-peptone broth and an infusion of cotton leaves seem to show that it is the pycnidial stage of an undescribed *Pleospora* which I have found on cotton leaves.

⁴Possibly also that of the *Phyllosticta*.

nate spores in favorable weather the leaf is soon covered with a mass of spores giving a blackened appearance to the leaves.

My correspondents in Alabama use the term "black rust" when the disease progresses very rapidly and the development of the hyphæ of *Cercospora* and setæ of *Colletotrichium*, or the *Macrosporium* and *Alternaria* spores, is very profuse causing the leaves to appear black. When the disease progresses more slowly, being checked by unfavorable weather, or is in the first stages, the term "red rust" is used. In such cases the *Macrosporium* or *Alternaria* has extended centrifugally the spots attacked by the *Cercospora*, increasing their size, causing them to become more nearly circular, and marking the spots with concentric lines. Also the edges of the leaf are dead and dried, and curled either below or upward, being favorite places for the attack of either the *Cercospora* or *Colletotrichium*. The body of the leaf is still green, paled by different shades of a dull yellow or dull purple.

In some cases in the early stages of the disease the *Colletotrichium* severely attacks the upper part of the stem of the plant and petioles of the leaves giving the stems a dark color from the internal changes, to the leaves a scalded appearance and causing them to shrivel and dry up much as if frost-bitten.

Sometimes the development of *Cercospora* may be so great and the attack of the other fungi so tardy as to give the appearance of "black rust" produced by it alone. Specimens of this kind were received from one of my correspondents at Eutaw, Ala. The conditions for the development of *Cercospora* were so favorable that from one-fourth to three-fourths of the leaf surface was covered with a dense mass of the dark brown hyphæ, the remaining portion of the leaf being yellowish with numerous small points of attack. The hyphæ and conidia in such cases are very long, often five to eight times as long as described by Cooke. Specimens collected at a later date at this place gave an abundance of the *Macrosporium* and *Alternaria*.

Where other fungi, as *Colletotrichium*, *Macrosporium* and *Alternaria* are abundant, it is often very difficult to find the *Cercospora* on the leaf. By placing the leaves, freshly gathered, in moist chambers for ten or twelve hours I have never failed to get an abundance of *Cercospora*, even on the smallest, uppermost leaves of the plant. Sometimes the *Macrosporium*

is the predominating fungus in the last stages of the disease giving a black appearance to the entire leaf.

Much speculation in agricultural papers has been indulged in regarding the cause of "black rust" of cotton. It is not proposed in this preliminary note to critically examine the various theories propounded. Some of my correspondents who formerly attributed the disease to the peculiar condition of the soil, lack of fertilizers, etc., say that sometimes in the best soil and with careful fertilizing the disease appears in a very destructive form. That has been abundantly proven during the past year under my own observation. *Cercospora*, *Colletotrichium* and *Phyllosticta* are all active parasites, and I am convinced from a year's study that *Cercospora Gossypina* is a more active and destructive parasite than has been formerly regarded. A diseased condition once started by such a fungus opens the way for the rapid growth and great injury produced by such forms as *Macrosporium* and *Alternaria*. It is possible the *Macrosporium* may infect the leaves unaided by other fungi. Inoculations of plants free from other forms must be made to determine this.

Cercospora Gossypina sometimes produces a serious spot disease of the cotyledons. I first observed this on some young plants started on the horticultural grounds, in September, for experimental purposes. I am told that sometimes in cold seasons in May this spot disease is quite injurious along with "sore shin."

While in North and South Carolina my attention was called to a disease termed "red rust" which was chiefly characterized by a reddening of the leaves not produced nor accompanied by any fungous growth. In most cases this seems to be due to some condition of the soil which induces a hastened maturity of the plant and the development of erythrophyll in the cell sap of the leaves. In some cases the development of erythrophyll is induced by the irritation of mites as I have proved by infection experiments. From several places in both states cotton quite severely injured by mites has been sent me. An account of this was published in Bulletin no. 4 of the South Carolina Agricultural Experiment Station, January, 1889.

The reddening of the leaves by the development of erythrophyll in the cell sap of the leaves is very common in some soils in Alabama and probably in all the cotton-producing states. It is quite possible that all through this belt there

are those who term this the "red rust," but so far as I have been able to learn by talking with farmers in Alabama, and from the specimens received, the term here is applied to the early, or arrested stages of "black rust" as I have described above.

Auburn, Ala.

Flowers and insects. VI.

CHARLES ROBERTSON.

Triosteum perfoliatum L.—In the bud the style is bent and the stigma is pressed against the opposing lobes of the corolla. As soon as the lobes separate the style straightens and the stigma is thrust out. The stigma rises from 3 to 4 mm. above the anthers and appears to be receptive while they are still indehiscent, so I regard the flower as proterogynous. The corolla continues to lengthen until the second stage. In this stage the anthers are dehiscent, and the stigma is turned to one side. The flowers are rather dark purple and collected in inconspicuous clusters in the axils of the perfoliate leaves. Nectar is secreted in a gibbosity in the base of the corolla. The corolla is from 14 to 16 mm. long and is adapted to long-tongued bees.

Visitors: (May 18 and 23) *Apidae*: (1) *Bombus Rivingii* Cr. ♀, s.; (2) *B. vagans* Sm. ♀, s., visited all of the open flowers and forced its proboscis into several buds, whose lobes had hardly begun to loosen, but which contained an abundance of nectar; (3) *B. americanorum* F. ♀, s.; (4) *Anthophora abrupta* Say ♂, s.; *Andrenidae*: (6) *Augochlora pura* Say ♀, s. and c. p., crawls into the tube; (7) *Halictus Lerouxii* St. Farg. ♀, c. p.

Cephalanthus occidentalis L.—The first peculiarity of the flower that strikes one is the great difference in the height of the anthers and stigma. Indeed, it looks like a long-styled dimorphous flower. The anthers are at the mouth of the tubular corolla, while the stigma rises 7 mm. higher. It looks as if the pollen could never touch the same part of the insect which comes in contact with the stigma. The disparity is accounted for by the fact that the style itself serves to expose pollen to the visitors. In the bud the anthers dehisce, depositing all of